MODIS Team Member -Semi-Annual Progress Report
Marine Optical Characterizations
January - June 1995

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SUMMARY

During the past six months, the MOCE Team conducted a field trip to the MOBY operations site at Snug Harbor, Honolulu, Hawaii, from March 3-27, 1995, prepared technical memoranda and reports, and continued MOCE-2 and MOCE-3 data reduction. The primary purposes of the field trip were to assemble the operational MOBY-2 buoy, test the along-track measurement systems and their associate software, and test the MOBY cellular phone communications link at the Lanai mooring site. A series of measurements were conducted in the harbor to verify the “remote sensing reflectance” protocols and examine the wave focusing effects on the computation of the spectral diffuse attenuation coefficients.

MOBY-L9 FIELD TRIP

The following personnel were involved:

NOAA - Dennis Clark, Yuntao Ge, Phil Hovey, Ed King, Eric Stengel,
Marilyn Yuen, Larisa Koval
MLML - Mike Feinholz, Mark Yarbrough, Yong-Sung Kim
CHORS - Jim Mueller, Dan Sullivan
Univ. of Hawaii - Mike Ondrusek

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) data acquisition software were tested and/or updated. All available instruments were tested in operational mode, including TRAK GPS station clock, Trimble GPS receiver, compass, barometer, air temperature and relative humidity sensor, wind monitors, pumping system flow meters, temperature/conductivity system, Turner fluorometer, SeaTech transmissometer and the VLST. Additional LabVIEW software systems (i.e. Master Log, Pigment Log, VLST Relay, and VLST Display) were also tested. The status of each instrument is given below:

- The new TRAK station clock and antenna work well. The old TRAK station clock was refurbished by the manufacturer. The unit lost track of its internal oscillator initially. However, after restarting, it worked without failure for the duration of the trip.

- Trimble GPS receiver worked well.

· The barometer was fully functional.

The compass sensor had previously been installed upside down (east and west directions were switched). Previous MOCE-2 and MOCE- 3 data will have to be discarded. The problem was corrected and the instrument functions properly.

The temperature and humidity sensor was found to be out of range and non-linear. The temperature reading was about 4 degrees lower than actual temperature at noon and about 2 degrees higher in the morning. The accuracy of the sensor was specified at 0.2 degree by the manufacturer. Since the humidity measurement is dependent on the temperature reading (correction factor was based on the temperature), both sets of data are in error. These sensors are being replaced.

The wind monitors demonstrated no problems. The calibration was done on the speed reading, and it was found that linearity was still excellent.

The SeaTech transmissometer cable connectors had corroded. New connectors were installed and a junction box was made for the computer interface. A 24 V DC power supply will be integrated within the junction box in order to provide a complete stand alone system. The acquisition software has to be modified to output the beam attenuation coefficient and transmittance at 1 meter. The photo diode emitter (light source) has degraded approximately 2% over the past two years (air cal reads 4.804 V instead of the reading 4.95V supplied by the manufacturer two years ago). However, the offset is being compensated for in the data reduction software.

Temperature and conductivity flow-through system operated properly.

Turner fluorometer operated well. No calibration was done. Raw data indicate that the sensitivity was excellent in the higher fluorescent waters present in Snug Harbor (i.e., in auto ranging mode, 3.5 V output was observed).

- The scattering meter was set up and used to measure the scattering coefficient of the Harbor water. It was found that at 543.2 nm, the scattering coefficient ranges from 0.0038 at the surface to 0.0064 at 3 meters.

Radiance and irradiance data were collected in an effort to verify the validity of the present SeaWiFS protocols recommended measuring remote sensing reflectance. An American Holographic dual input spectrometer (Rainbow) was tested during the remote sensing reflectance measurements and was found to have severe cross-channel interference (40% and 20% maximum reflected energy on the other channel was observed in the case using a standard lamp). This interference affected about 50 pixels within each of the spectral input ranges. This deficiency is presently thought to be inadequate blocking of the zero order. Additionally, radiance and irradiance data were collected for determining whether or not wave focusing affects diffuse attenuation data. This was done by collecting MOS Ed and Lu data sets at predetermined, coincident heights and depths (Fig. 1). For Lu data collected above the water surface, a Gershen tube was used to restrict the light source(s) for the Lu detector.

Other in-water properties were also measured, including total suspended matter, pigments for HPLC analysis, particle size and scattering, beam transmission, temperature, and salinity. Subsurface video footage of the underwater light field was acquired in order to provide data for studies on wave slope distributions .

Total and sky irradiance data were collected during clear and overcast conditions. These data are being used to calculate the reflectance functions for both above and below the water surface for a variety of solar zenith angles and wind speeds (Fig. 2).

A new mobile storage/equipment hut for shipboard use was built. This included installing storage racks, electricity, lighting, and air-conditioning.

MOCE INSTRUMENTATION

TOWED SYSTEM

The Chelsea fluorometer was returned from the factory after repairs, as the unit had flooded during the MOCE-3 cruise. Chelsea believes the leak to be from an O-ring or a bad connector. Leakage through the connector is the most likely cause, as the connector is under a great deal of flex stress due to being mounted in the V-fin. The old connector and O-ring were not returned for inspection as requested so verification was not possible. The connector was changed to a low profile connector which will fit better in the V-fin. The resistor, which was fixed during the MOCE-3 cruise, was of the correct value so the instrument calibration should be similar to the previous cruises. Work is continuing on a new submersible electrical junction box which will eliminate the old RTV sealed unit which develop leaks after prolonged deployment periods. The new unit will be available before the next cruise.

AC-9

The nine-channel absorption and beam attenuation (AC-9) instrument is back at Wet Labs for repairs, Initially the unit was returned because a different channel exceeding the noise specifications was found, This filter was not replaced during its last service because Wet Labs was out of the required filter, and the noise (,0019 units) on that channel was very close to specifications (<.001 units), As of now, there are no mechanical upgrades to the instrument. Wet Labs has improved the instrument electronics and encoder firmware but these changes only improve instrument serviceability on their end. Wet Labs has changed filter manufacturers. The old filters from Andover were degrading at a rapid rate (one of our major problems), so they have changed vendors and now use OCA filters. However, Wet Labs has no data on the long-term stability of these filters. Wet Labs is still working on the exact upgrade path and costs for all the AC-9s. They are offering such upgrades “at cost”. A quotation for the cost to bring the instrument up to current specifications has been requested, The programs and documentation for the processing software are complete; however, some work remains in developing a workable file naming scheme and in automating some of the input/output file naming in the processing software.

MODAPS

MODAPS was repaired and is operating properly, The motherboard in the unit had a cold solder joint producing the erratic startup operation observed during the MOCE-3 cruise. The work on the MODAPS data extraction programs was completed by CHORS. These programs will place GPS time indexed AC-9 data into a MAC compatible format. Some work remains in testing the merging program. Programs have been developed to simplify the air calibration tasks. These programs produce a file for use by the Wetview program to apply the air calibration data during AC-9 data acquisition.

MARINE OPTICAL BUOY

SOFTWARE DEVELOPMENT

Personnel from MLML are continuing their work on the MOS-2 software. All of the individual programming tasks for MOS-2 have been written and tested. The entire system still awaits the delivery of spectrographs, When all components have been assembled, then the complete software/hardware system will be tested. XMODEM file transfer protocol has been added to the Forth system on the MOBY computer. It operates at twice the speed as Kermit, but it is not as robust in error checking. XMODEM will be used when possible, but if the connection is too noisy, Kermit will be used instead. A/D converter routines have been completed which allow reading 16-bit data from all of the 16 analog channels including pressure, water temperature, MOS internal temperatures, tilt, reference voltages and current, and coolant flow. D/A converter routines have been completed to provide 16-bit analog outputs to control the calibration LEDs and as yet unspecified other uses. Four D/A channels are available. Power control board relays have been increased from 22 to 30 which required a change in software. Following the completion of wiring for the MOS-2 circuit boards, testing these routines on the hardware showed that a printed circuit board was mistakenly designed, but bit-shifting in the software corrected the problem.

Mirror control and fiber optics multiplexer software similar to that used with the prototype was adapted for use on MOS-2. The original commands for the multiplexer were retained; the only difference is that the new routines work directly with a new stepper motor controller. Setting one of the optics input channels will now be about three times faster than that on the prototype.

The VMS data acquisition program must be changed to match the new data formats transmitted from MOS. These changes include additional D/A channels, D/A output, power control status, revision of integration times, and changes to parameters for the blue and red spectrographs. The work is continuing on replacing the obsolete UIS window procedures with DEC windows. The UIS window procedures were originally used on the old VAXstation II/GPX, and these procedures are translated into DEC windows on the VAXstation 4000/60. Use of DEC windows should speed up data acquisition considerably. In addition, DEC windows allows us to plot graphs and text in color (UIS is only black-and-white). The programming of these new modules was completed.

HARDWARE DEVELOPMENT

MOS

The majority (12 of 14) of the printed circuit boards have been fabricated and electronic components are being integrated. The major mechanical work remaining is to completely disassemble the MOS units to allow modification of the internal parts. These modifications consist mostly of drilling holes to mount the parts listed above. The remaining 3 boards must wait until the internal layout of the instrument is complete. The internal layout can be finalized shortly after American Holographic furnishes final design drawings of the new spectrograph. The preliminary design information on the spectrograph (the VS-10) has been sent to MLML. The unit was about 0.25” too big in one dimension which interfered with the TT7 controller rack. Pressure housing space constraints requires the CCD array cooling system to be mounted external to MOS. The cooling system contains the circulating pump and two heat exchangers. The system is powered by MOS through extra pins in the MUX connector. This configuration will require more parts fabrication, but it is the best solution.

MOBY PROTOTYPE

A mockup MOBY controller with cellular phone was built and deployed on the mooring marker buoy at the Lanai site. This controller allowed testing cell phone communications at the site, TT7 data transfer protocols (Kermit) and the internal Modem setups, An easy-to-install rack was built to allow mounting the electronics boxes and a solar panel to the mooring float. The unit was installed on the mooring at 13:00 (+10) on March 25, 1995, via chatter boat from Hawaiian Rafting Adventures (hereafter referred to as HRA). A full MOBY data file 250 K bytes was transferred via cell phone in 26 minutes at 23:00 (+10) on March 25. The unit was operational on March 26 but stopped operating on March 28. HRA recovered the unit on April 2. Initial testing by HRA indicated that the unit could not be turned on manually. However, on April 5 the unit turned itself on and off properly. The unit has not operated since. The fact that it turned itself on properly at the correct time at some point indicates that the TT7 and its operating system are functioning properly but suffers from a faulty power system. The failure is likely a bad Lithium battery, battery isolation diode, or a bad internal connection. We did learn that efficient cell phone communications/data transfer from the MOBY site is possible. The unit has been returned to MLML for software and hardware testing.

MOBY v2

MOBY #2 and components of MOBY #3 were delivered to Hawaii and MOBY #2 was assembled (Fig. 3). An adjustable supped platform was built to ease buoy assembly. MOBY #1 (prototype upgrade) and MOBY #3 surface floats were fabricated at Mooring Systems Inc. and delivered to MLML in May. The remaining mechanical components of all three MOBYs are complete except for coatings. The powder coating should work well if the base metal is properly prepared. The replacement Fiber Optic Multiplexer (MUX) is being built at Aurora Optics Inc. Aurora is also designing and fabricating PVC covers to isolate the exposed sensitive portions of the MUXs from seawater. The fiber optics collector order was placed with Research Support Instruments Inc. The RSI design was accepted and fabrication is in progress. Delivery is expected the end of July.

Battery terminal seals and cable parts have been completed for the lower section of the last two MOBYs. The work on the top antenna and collector mounting system is in progress.

DATA REDUCTION

MOCE-2

The reconstruction of MOCE-2 data sets is continuing. The old processed data sets were corrupted, so it was necessary to start again from raw data. There are excessive drop outs in the data due to hardware malfunction or operator error. Some of the data, however, were misnamed or misplaced by the acquisition software. It was necessary to go through each hour of the raw data to search for these inconsistencies. When a problem was identified, the data were moved to the proper place in the time sequence and renamed. After this was completed, the corrected data were binned into stations and casts. The data are now ready to be processed.

Scanning of MOCE-2 skycam data is complete. There is a time offset between real time and the skycam data time stamps. After these offsets are corrected, the sky scenes will be produced for the concurrent underwater data sets.

The MOCE-2 radiance and irradiance attenuation profiles and pigment data from CHORS as well as the CTD profiles and particulate data from MLML have been transferred to NASA.

<u>MOCE-3</u>

The majority of data collected during MOCE-3 have been preliminarily processed. The meteorological, navigational, VLST (both along track and profile), flow meter, and MER radiometric data sets have had first level conversion factors applied, and initial quality control efforts are underway with these particular data sets. Processing of the CTD profile data has been concluded and final quality control checks are underway. Approximately 70% of the CDOM absorbance data have undergone precursory processing steps. The particulate (TSM, POC, PON) and MOS radiometric data have not been processed yet.

Steps were taken to further improve and streamline the software and data “flow.” The main bottleneck involves scanning data sets for “outliers.” Towards that end, programs were developed to scan a list of filenames containing MOS or SIS radiometer data and flag files containing errors such as off scale scans, incomplete or extended scan-sets, and improper sequencing of scan types. This initial series of automated error detection will be expanded as software/hardware debugging continues. Other programs were written to create Postscript multiple-panel hard-copy plots of spectral data. These aid in examining data for quality issues such as:

- o Were incident lighting conditions during the underwater scan-sets stable enough to allow averaging of multiple sets?
- o For multiple sets that cannot be combined, which has the highest signal to noise ratio?
- o Can the means be optimized by using S/N criteria for deleting scans?

Some programs were improved for extracting and listing ancillary data such as instrument temperature (internal and external), cooler flow, integration time, water pressure, and acquisition time. Improved log sheets annotated by the operator during instrument deployment have aided in spotting problems involving rough sea and/or sky conditions, or problems with instrument operation. Together, log sheets, ancillary data, and spectral plots are used to select data files to be used during the processing steps of editing, merging, dark-adjusting, converting, deriving, smoothing, clipping, and creating final listings, graphical, and ASCII file output. Sample output from MOCE-3 Station 16 is shown on Figures 4, 5, and 6.

The software to bin MOS spectral data at SeaWiFS bandwidths was revised. SeaWiFS relative spectral response for band numbers one to eight are used to examine the effects of in-band and out-of-band response. In this context, out-of-band is defined as that response below the one percent level or outside the primary band-pass of the interference filter. Examples shown in Figures 7 and 8 are from the upwelled radiance MOS data at 12 meters which have been binned to match the SeaWiFS in- and out-of-band responses and in-band only response respectively. Software has been completed in which the Fraunhoffer lines or chlorophyll-a fluorescent line-height can be extracted from between given sequences in either an absolute-unit or ratioed mode, and with either linear or log-linear regression performed between endpoints to calculate base levels between endpoints. A 30-day time series (derived from the initial MOBY deployment) of the peak fluorescence wavelength and the fluorescence line height between 660 and 700 nm are illustrated in Figures 9 and 10.

The data obtained during the MOBY-9 field trip using the new American Holographic Rainbow miniature two channel spectrometer and the HHCRM have been processed. It was found out that cross talk between the two channels was severe. More than 60 pixels out of 128 of each channel were affected as shown in Figure 11. American Holographic is reviewing this cross talk problem. In the mean time, the effect can be avoided by using only one channel at the time of measurement. More measurements are planned in the near future for testing the reflectance measurement protocol proposed in the SeaWiFS Technical Report, volume 25.

The HHCRM data is being used to produce the relative sky radiance and sun direct radiance ratios. A set of data taken in Hawaii from the last field trip produced ratios which varied from 0,1 to 0.7 spectrally as a function of solar zenith angles (Figure 12). This variance and associated polarization is important to the removal of the sky radiance effect in the determination of the remote-sensing reflectance function. The polarization measurements will be included in the next set of observations. Additionally, the effect of the air-sea interface on the remote reflectance function is being investigated. The effect of wind speed and solar zenith angle are shown in Figures 13 and 14 and illustrates that the ratio of reflectance reflectance measured above and below the surface may differ significantly from the commonly used ratio of 0,54 depending on the specific wind speed and solar zenith angle.

Other analysis software have been developed to produce graphical presentations which illustrate parameter variability for along track and high spatial resolution area maps as shown in Figures 15 and 16. Figure 15 shows pigment concentration circumnavigating Kanai and Niihau Islands. In Figure 16 a contoured pseudo-color illustration depicts a high resolution distribution of pigments in a 4x4 mile area.

These methods will be used for validating products and determining interpixel variability.

DOCUMENTATION

Moss Landing Marine Laboratories personnel have prepared five technical reports and two technical memoranda and Center for Hydro-Optics and Remote Sensing personnel prepared one technical memorandum (Appendix 1) .

SUPPORTING GRANTS AND INTERAGENCY ACTIONS

Grant renewals to San Diego State University foundation (CHORS) and San Jose State University foundation (MLML) were completed.

Funds for the MOCE-3 University of Hawaii R/V Moana Wave ship time were transferred to the National Science Foundation.

The Research and Data Systems (RDS) Corporation program support contract has been renewed. The paperwork has been submitted to initiate a contract with RDS for science support.

APPENDIX 1

Feinholz, M. E. and S.J. Flora (1995) Oceanographic profiling and spectroradiometer observations from the Marine Optical Characterization Experiment Cruise-2 (MOCE-2), Baja California, 28 March to 14 April 1993. MLML Technical Publication 95-1.86 pp.

Feinholz, M. E., S.J. Flora and J.A, Gashler (1 995) Oceanographic results from the Lanai-7 MOBY maintenance cruise 25 to 30 June 1994. MLML Technical Publication 95-2.46 pp.

Feinholz, M.E. and S.J. Flora (1995) Oceanographic profiling and spectroradiometer observations from the Marine Optical Characterization Experiment Cruise-3 (MOCE-3), 27 October to 15 November 1994, MLML Technical Publication 95-3.

Broenkow, W.W., M.E. Feinholz and J, A, Gashler (1995) Data Reduction using the SBE 9/11 plus CTD system and SEASOFT Programs. MLML Technical Memorandum 95-1.30 pp.

Sullivan, D. (1995) MODAPS Processing Software for MOCE-3 Cruise. Center for Hydro-Optics and Remote Sensing (CHORS) Technical Memorandum.

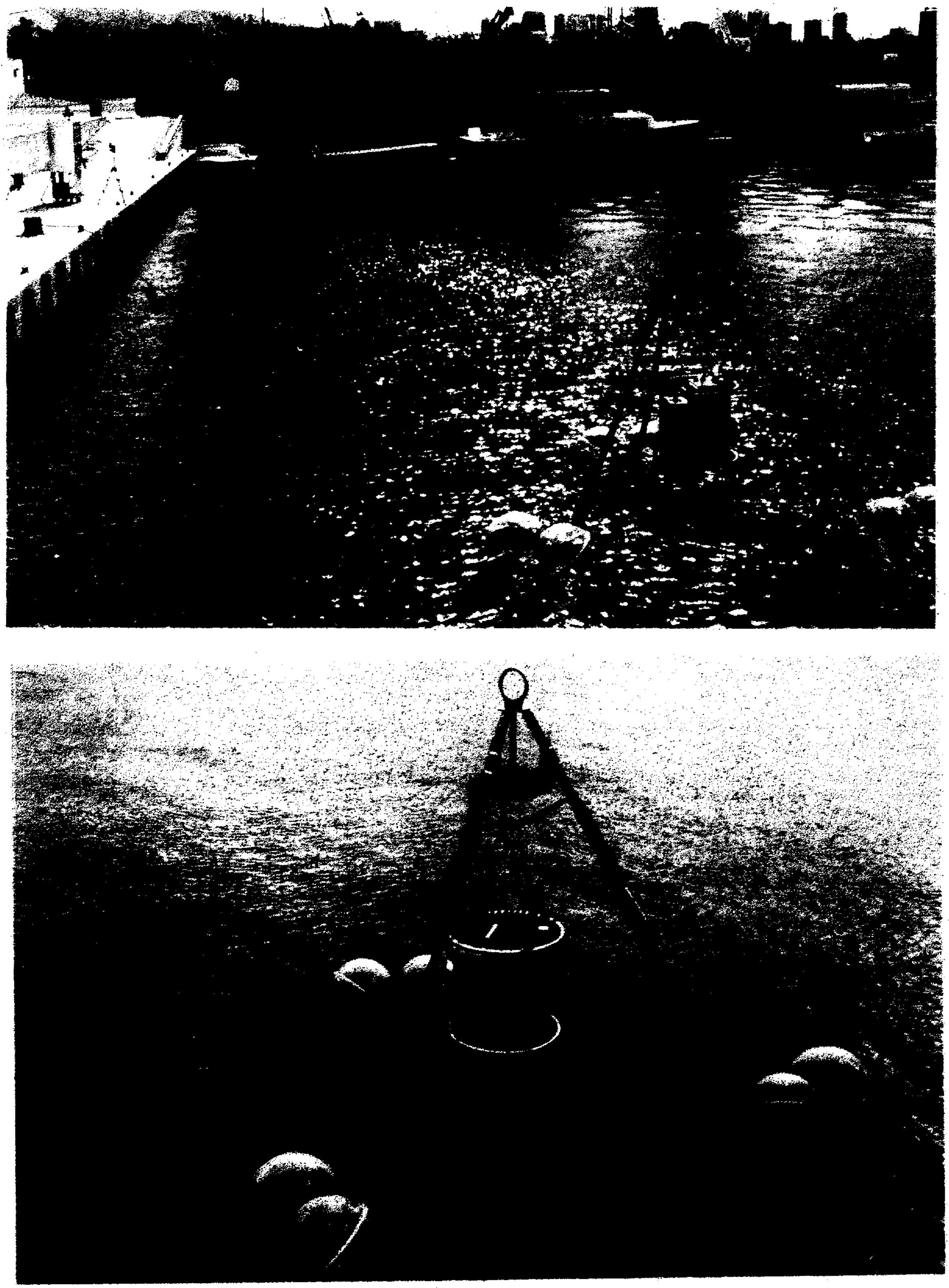

FIGURE 1.

FIGURE 2.

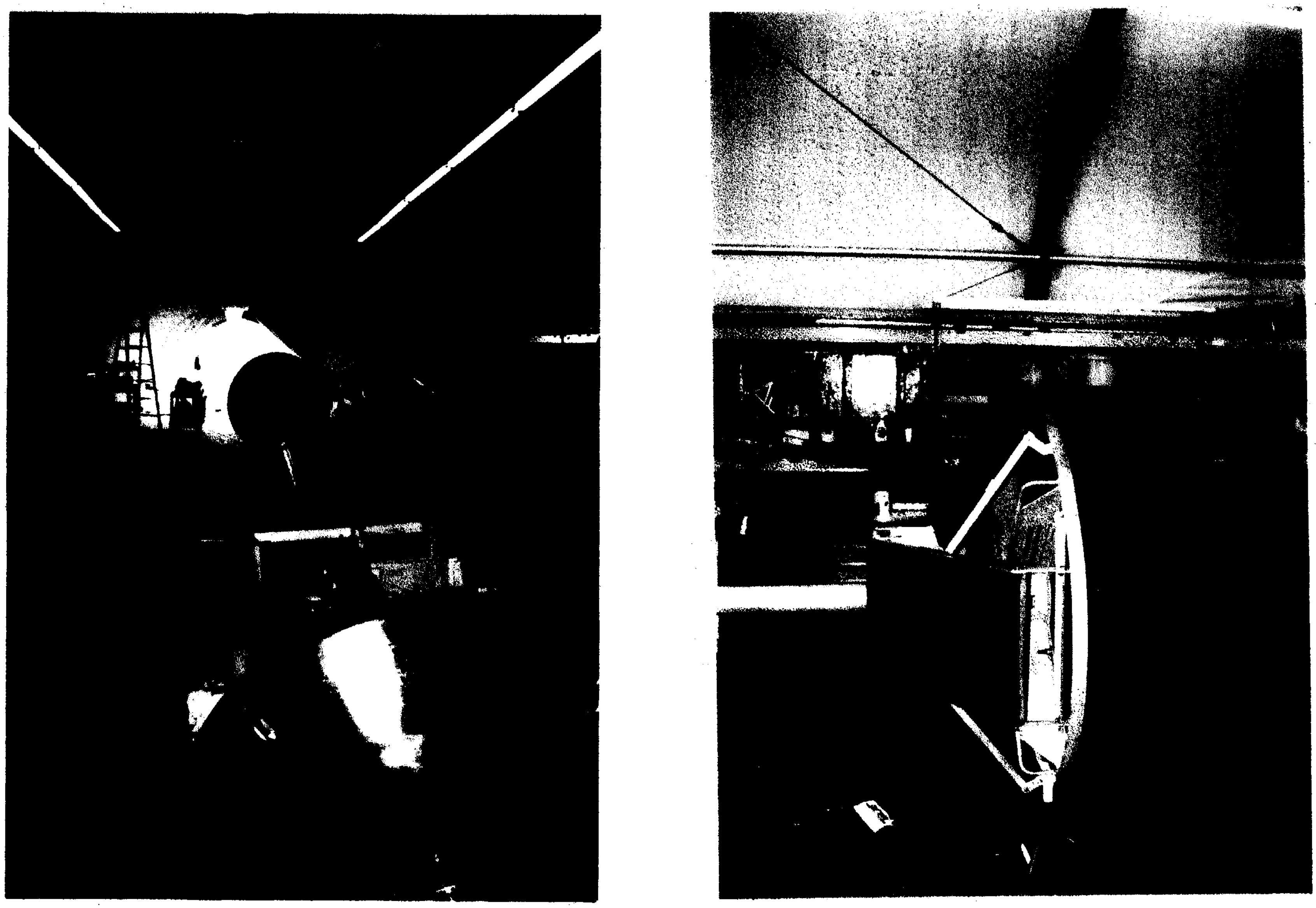

FIGURE 3.

ttu
ilahi
iint)

MOS DATA ACQUISITION LOG

Cruise: MOCE-3 **Ship:** R/V Moana Wave **Cruise Dates:** 27 Oct - 15 Nov 94

MOS: Serial # 1 **Cfg #** ~~10~~ 6 **Filter Information:** 1.5 neutral density Ed filter

MUX: Serial # ~~3~~ **Cfg #** +

Deck **Pressure:** **Start** 0.78 **End** 0.88

Int Temp: **Start** 32.96 **End** 32.47

Stn #	Start Time	Battery Level	Integration Time Blue	Integration Time Red	Data Filename	Comments
16	22:00 to	0.26	0.5	1	stn16_sfc_Ed_01	Nominal Z = 1m kinda sloppy
	22:05	0.25	↓	↓	↓ _02	— NOT FOUND wF ↓
	22:10	0.24	0.25	16	stn16_sfc_Lu_01	
	22:18	0.25	↓	↓	↓ _02	
	22:31	0.23	0.5	2	stn16_nrsfc_Ed_01	Nominal Z = 3m kinda sloppy
	22:35	0.22	↓	↓	↓ _02	↓
	22:40	0.22	0.5	16	stn16_nrsfc_Lu_01	cloud overhead; scans 4+5 higher
	22:52	0.23	0.25		_02	clouds?
	23:00	0.22	↓	↓	↓ _03	scan 1 real high; messy!
	23:14	0.22	1	16	stn16_mid_Ed_01	Nominal Z = 11m
	23:22	0.22	↓	↓	↓ _02	scan 5 is high
	23:31	0.21	0.5	16	stn16_mid_Lu_01	sloppy blues
	23:39	0.23	↓	↓	↓ _02	
	23:51	0.23	2	16	stn16_btm_Ed_01	Nominal Z = 21m
	23:59	0.22	↓	↓	↓ _02	scan 5 is high
	00:08	0.20	1	16	stn16_btm_Lu_01	
↓	00:15	0.19	↓	↓	↓ _02	

Blue array temp never got quite as cold as it has been for this cruise (~1 deg warmer) at the sfc.

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* Got a check sum error upon recovery again (3x out of the last 4 recoveries!).

FIGURE 4. Improved radiometric data acquisition log, from MOCE-3 Station 16. Note: Comments entered by operator are very useful during data pre-processing.

MOS MLML DBASE Variable Extension data (rev 29-Jan-1994)

File: stn16_sfc_ed_o1

Var	Scn	Type	Mux	Mir	Date	Time	B/RCOO	B/R int	Pres	Xtlt	Ytlt	Flow	Cmpas	OutT	IntT	LedT	BluT	RecT
1	0	Wave	O	0	01 Jan70	00:00:00	0/0	0.25/0.25	999.0	999.0	999.0	999.00	999.0	999.0	999.0	999.0	999.0	999.0
2	1	Dark	O	1	14 Nov94	22:02:17	38/45	0.50/1.00	1.9	-2.2	-2.6	0.25	229.8	23.3	33.2	76.5	-0.9	-2.9
3	2	Dark	O	1	14 Nov94	22:02:41	38/45	0.50/1.00	1.9	-1.7	-2.8	0.25	240.6	23.6	32.8	76.4	-0.8	-2.9
4	3	E d	0	5	14 Nov94	22,03,06	38/45	0.50/1.00	1.9	-1.9	-2.8	0.25	243.0	23.3	33.2	76.5	-0.9	_2.9
5	4	E d	0	5	14 Nov94	22:03:26	38/45	0.50/1.00	1.9	-2.7	-2.8	0.25	224.7	23.6	32.7	76.3	-0.8	_2.9
6	5	E d	0	5	14 Nov94	22:03:46	38/45	0.50/1.00	1.9	-2.6	-1.8	0.25	215.7	23.3	33.1	76.5	-0.8	_2.9
7	6	E d	0	5	14 Nov94	22:04:06	38/45	0.50/1.00	1.9	-3.7	-2.8	0.24	218.3	23.6	33.0	76.5	-0.8	-3.0
8	7	E d	0	5	14 Nov94	22:04:26	38/45	0.50/1.00	1.8	-1.5	-2.3	0.25	234.0	23.1	33.2	76.5	-0.8	-3.0
9	8	Dark	O	1	14 Nov94	22:04:48	38/45	0.50/1.00	1.9	-1.1	-2.5	0.26	213.2	23.3	32.7	76.2	-0.8	-3.0
10	9	Dark	O	1	14 Nov94	22:05:08	38/45	0.50/1.00	1.9	-2.5	-2.8	0.25	225.9	23.5	32.9	76.6	-0.8	_3.2

File : stn16_sfc_lu 01

Var	Scn	Type	Mux	Mir	Date	Time	B/RCOO	B/R int	Pres	Xtlt	Ytlt	Flow	Cmpas	OutT	IntT	LedT	BluT	RecT
1	0	Wave	O	0	01 Jan70	00:00:00	0/0	0.25/0.25	999.0	999.0	999.0	999.00	999.0	999.0	999.0	999.0	999,0	999.2
2	1	Dark	O	1	14 Nov94	22:12:57	38/45	0.25/16.00	1.8	-3.1	-2.8	0.24	208.6	23.3	32.9	76.3	-0.6	-2.9
3	2	Dark	O	1	14 Nov94	22,13:48	38/45	0.25/16.00	1.9	-2.3	-2.5	0.25	217.4	23,2	33.2	76.5	-0.5	-3.0
4	3	L u	0	3	14 Nov94	22,14,38	38/45	0.25/16.00	1.9	-3.1	-2.8	0.26	210.0	23.1	33.1	76,4	-0.5	-3.2
5	4	L u	0	3	14 Nov94	22:15:24	38/45	0.25/16.00	1.9	-2.5	-2.2	0.25	196.1	23.4	33.0	76.7	-0.5	-3.2
6	5	L u	0	3	14 Nov94	22:16:11	38/45	0.25/16,00	1.9	-2.8	-2.0	0.26	201.7	23.2	33.0	76.6	-0.5	-3.2
7	6	L u	0	3	14 Nov94	22:16:58	38/45	0.25/16.00	1.9	-3.1	-2.2	0.25	203.9	23.5	32.6	76.6	-0.5	-3.2
8	7	L u	0	3	14 Nov94	22:17:44	38/45	0.25/16.00	1.9	-1.7	-2.9	0.25	199.8	23.6	33.1	76.7	-0.5	-3.1
9	8	Dark	O	1	14 Nov94	22:18:34	38/45	0.25/16.00	2.0	-2.3	-2.8	0.24	208.6	23.3	33.2	76.7	-0.5	-3.0
10	9	Dark	O	1	14 Nov94	22:19:21	38/45	0.25/16.00	1.8	-1.7	-1.6	0.25	198.8	23.5	33.2	76.7	-0.5	-3.0

File: str.16_sfc_lu_02

Var	Scn	Type	Mux	Mir	Date	Time	B/RCOO	B/R int	Pres	Xtlt	Ytlt	Flow	Cmpas	OutT	IntT	LedT	EluT	RecT
1	0	Wave	O	0	01 Jan70	00:00:00	0/0	0,25/0.25	999.0	999.0	999.0	999.00	999.0	999.0	999.0	999.0	999.0	999.0
2	1	Dark	O	1	14 Nov94	22:20:46	38/45	0.25/16.00	1.9	-2.5	-2.8	0.25	203.4	23.4	33.1	76.7	-0.5	-3.1
3	2	Dark	O	1	14 Nov94	22:21:33	38/45	0.25/16.00	1.9	-2.0	-2.6	0.24	225.7	23.4	33.1	76.5	-0.5	-3.0
4	3	L u	0	3	14 Nov94	22:22:23	38/45	0.25/16.00	1.9	-2.3	-2.8	0.25	217.6	23.1	33.2	76.8	-0.5	-3.0
5	4	L u	0	3	14 Nov94	22:23:10	38/45	0.25/16.00	1.9	-2.7	-2.8	0.24	210.3	23.7	33.0	76.8	-0.4	-3.0
6	5	L u	0	3	14 Nov94	22:23:56	38/45	0.25/16.00	1.8	-2.2	-2.8	0.25	208.3	23.5	33.1	76.5	-0.4	-3.1
7	6	L u	0	3	14 Nov94	22:24:43	38/45	0.25/16,00	1.8	-1.9	-2.8	0.25	209.3	23.4	32.8	76.8	-0,4	-3.2
8	7	L u	0	3	14 Nov94	22:25:30	38/45	0.25/16.00	1.8	-2.6	-2.6	0.25	198.6	23.6	32.9	76.7	-0.4	-3.2
9	8	Dark	O	1	14 Nov94	22:26:19	38/45	0.25/16.00	1.8	-0.7	-2.7	0.26	225.9	23.3	33.1	76.7	-0.4	-3.2
10	9	Dark	O	1	14 Nov94	22:27:06	38/45	0.25/16.00	1.9	-2.0	-2.7	0.25	203.2	23.5	33.2	76. ?	-0.4	-3.2

File: stn16 nrsfc ed 01

Var	Scn	Type	Mux	Mir	Date	Time	B/RCOO	B/R int	Pres	Xtlt	Ytlt	Flow	Cmpas	OutT	IntT	LedT	BLuT	RecT
1	0	Nave	O	0	01 Jan70	00:00:00	0/0	0.25/0.25	999.0	999.0	999.0	999.00	999.0	999.0	999.0	999.0	999.0	999.2
2	1	Dark	O	1	14 Nov94	22:32:50	38/45	0.50/2.00	4.1	-2.5	-2.7	0.23	172.9	23.4	32.7	77.0	-0.4	-3.3
3	2	Dark	O	1	14 Nov94	22:33:11	38/45	0.50/2.00	4.0	-2.6	-1.8	0.23	179.3	23.4	32.6	77.0	-0.4	-3.3
4	3	E d	0	5	14 Nov94	22:33:37	38/45	0.50/2.00	4.0	-0.3	-1.6	0.24	209.5	23.4	32.8	76.9	-0.4	-3.3
5	4	E d	0	5	14 Nov94	22:33:59	38/45	0.50/2.00	4.2	-1.6	-2.5	0.23	208.8	23.6	32.6	77.0	-0.4	-3.3
6	5	E d	0	5	14 Nov94	22:34:20	38/45	0.50/2.00	4.0	-1.5	-0.8	0.24	208.6	23.2	33.1	76,9	-0.4	-3.3
7	6	E d	0	5	14 Nov94	22:34:41	38/45	0.50/2.00	4.0	-2.0	-1.5	0.23	191.5	23.5	33.0	77.0	-0.4	-3.3
8	7	E d	0	5	14 Nov94	22:35:03	38/45	0.50/2.00	4.0	-1.5	-1.7	0.23	207.8	23.2	32.8	77.0	-0.4	-3.3
9	8	Dark	O	1	14 Nov94	22:35:26	38/45	0.50/2.00	4.0	-1.2	-1.4	0.23	192.0	23.3	33.0	76.9	-0.4	-3.3
10	9	Dark	O	1	14 Nov94	22:35:48	38/45	0.50/2.00	4.0	-2.2	-2.0	0.23	183.4	23.1	33.1	76.9	-0.4	->. :

FIGURE 5. Partial MOS ancillary data listing from MOCE-3 Station 16.

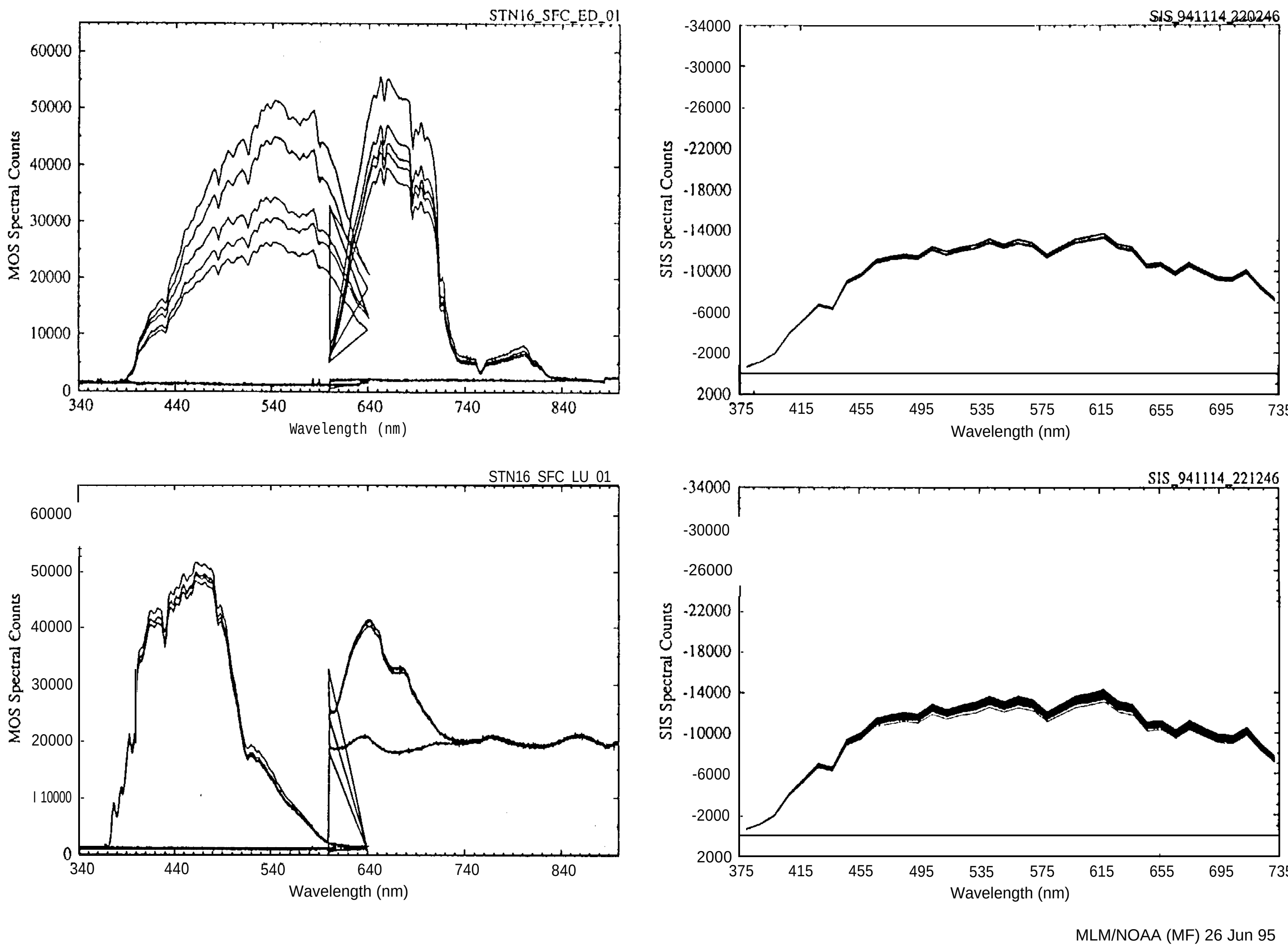
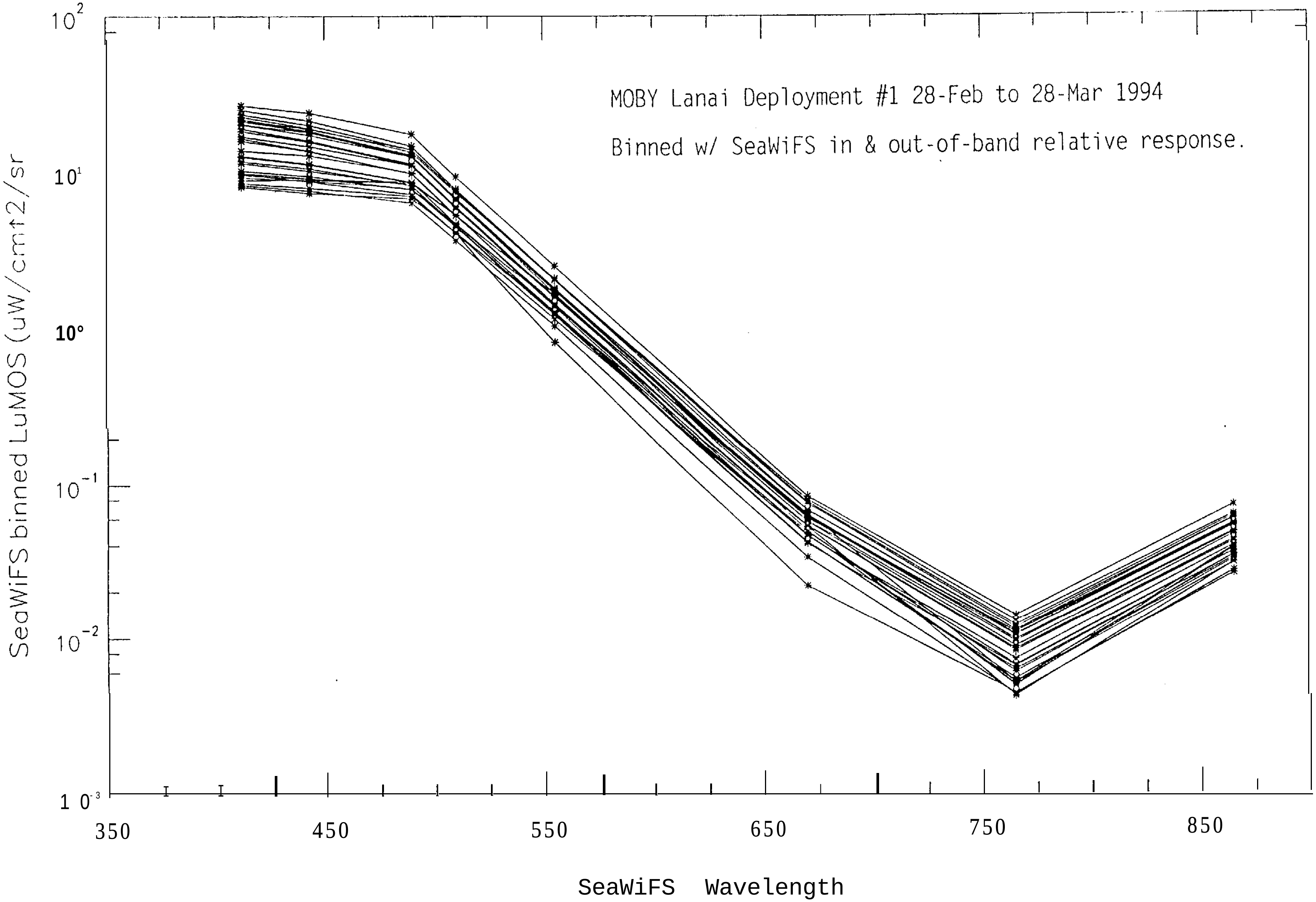


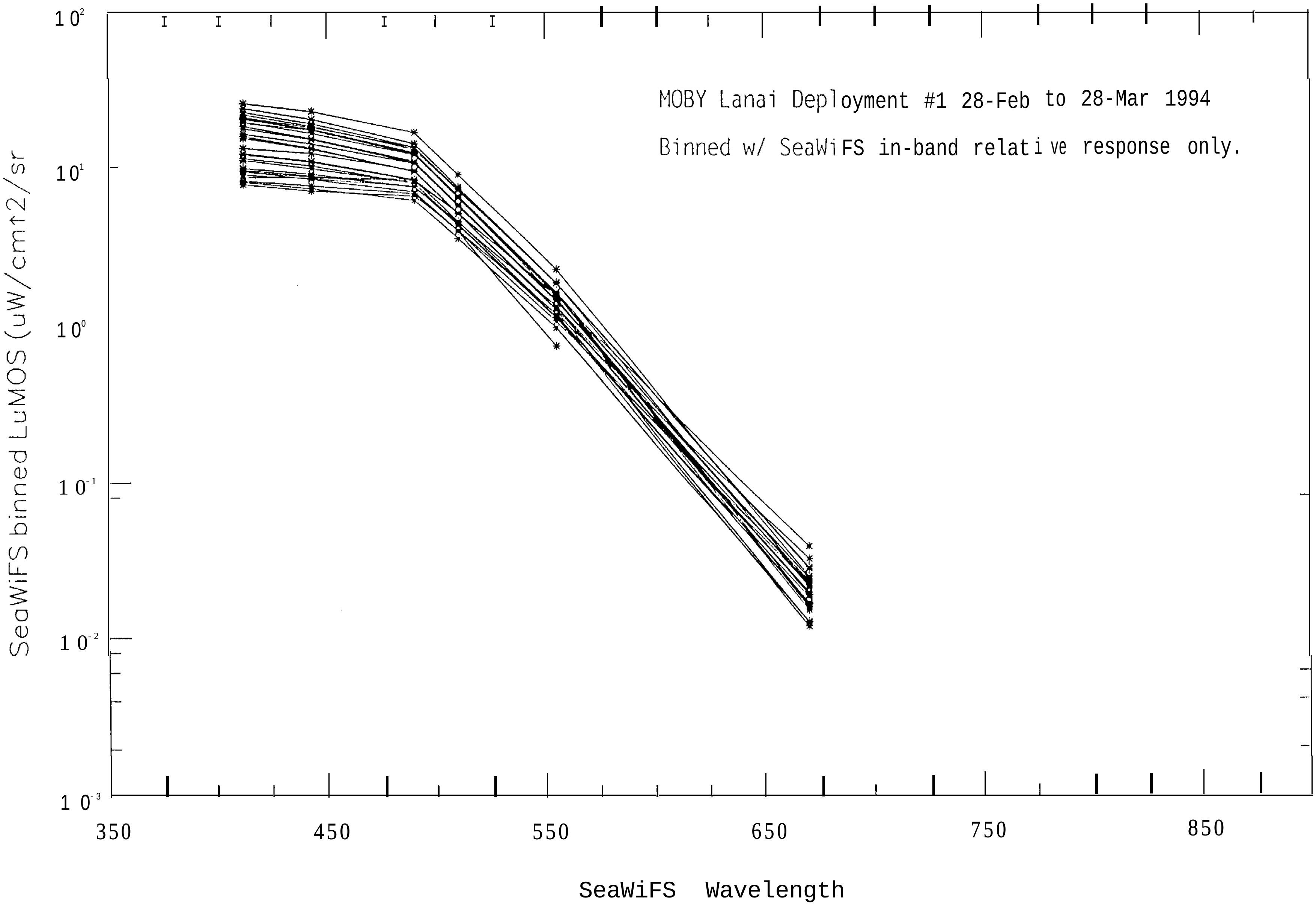
FIGURE 6. Raw MOS and SIS spectral scan data from MOCE-3 Station 16. Note: All SIS Es scans during a MOS scan-set are overplotted.



ALL~ LU ~ SEAWIFS ~ 2

FIGURE 7.

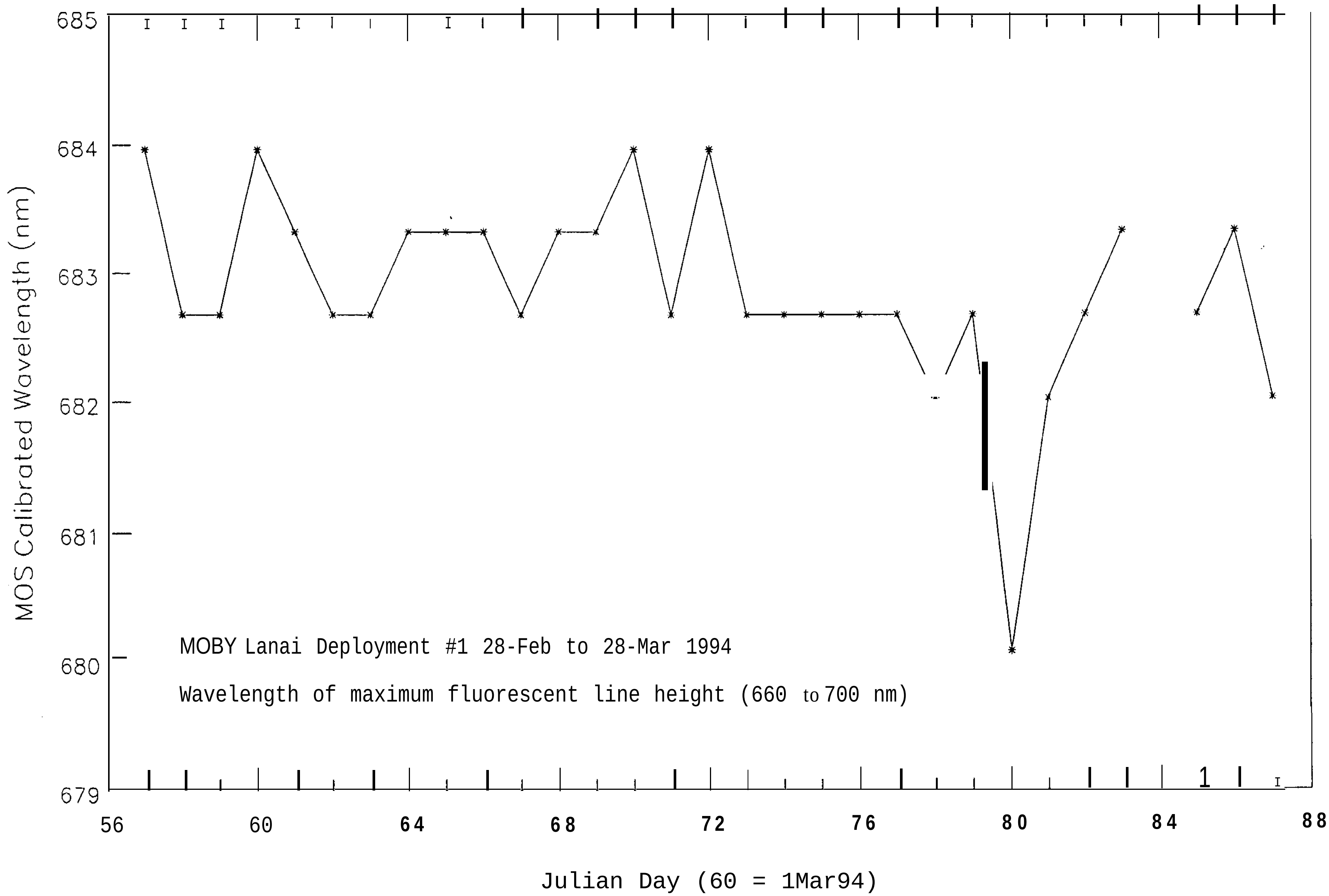
NOAA/MLML (MF) 26 Jun 95



ALL ~ LU ~ SEAWIFS ~ 3

FIGURE 8.

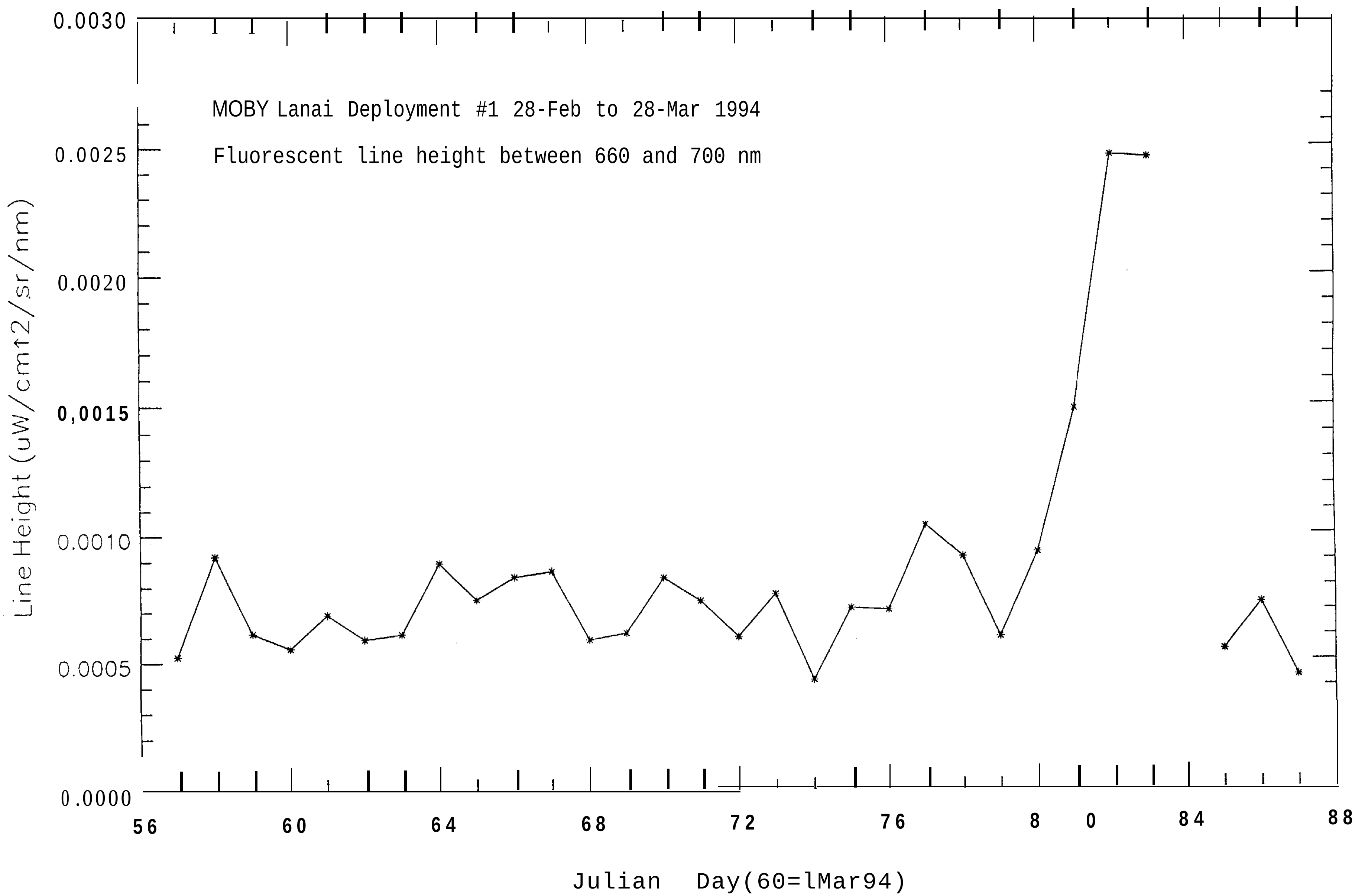
NOAA/MLML (MF) 26 Jun 95



ALL ~ LU ~ FL ~ LINE ~ HT

FIGURE 9.

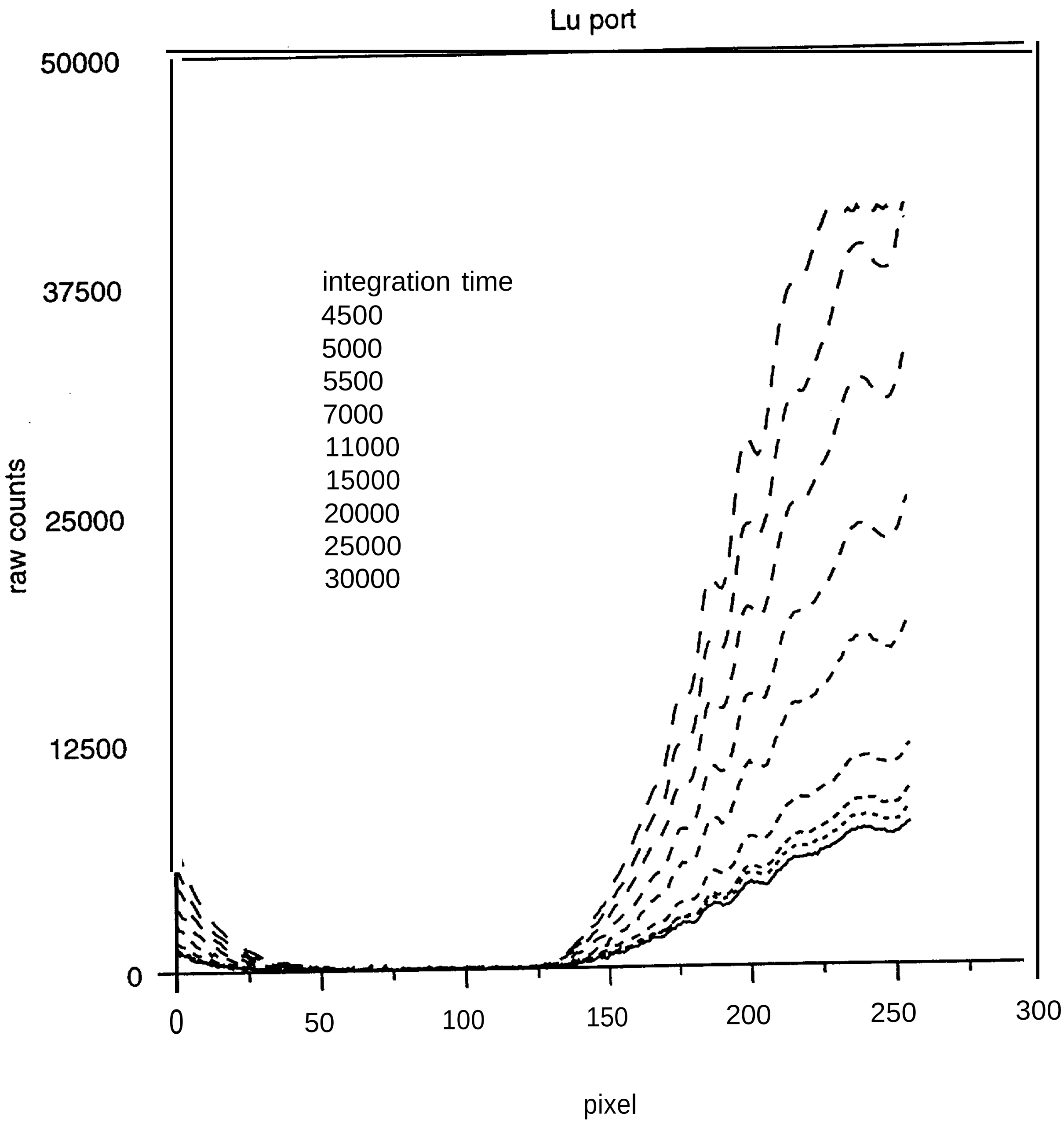
NOAA/MLML (MF) 26 Jun 95



ALL ~ LU ~ FL ~ LINE ~ HT

FIGURE 10.

NOW/MLML (MF) 26 Jun 95



left port blocked. see light leak from other channel

FIGURE 11.

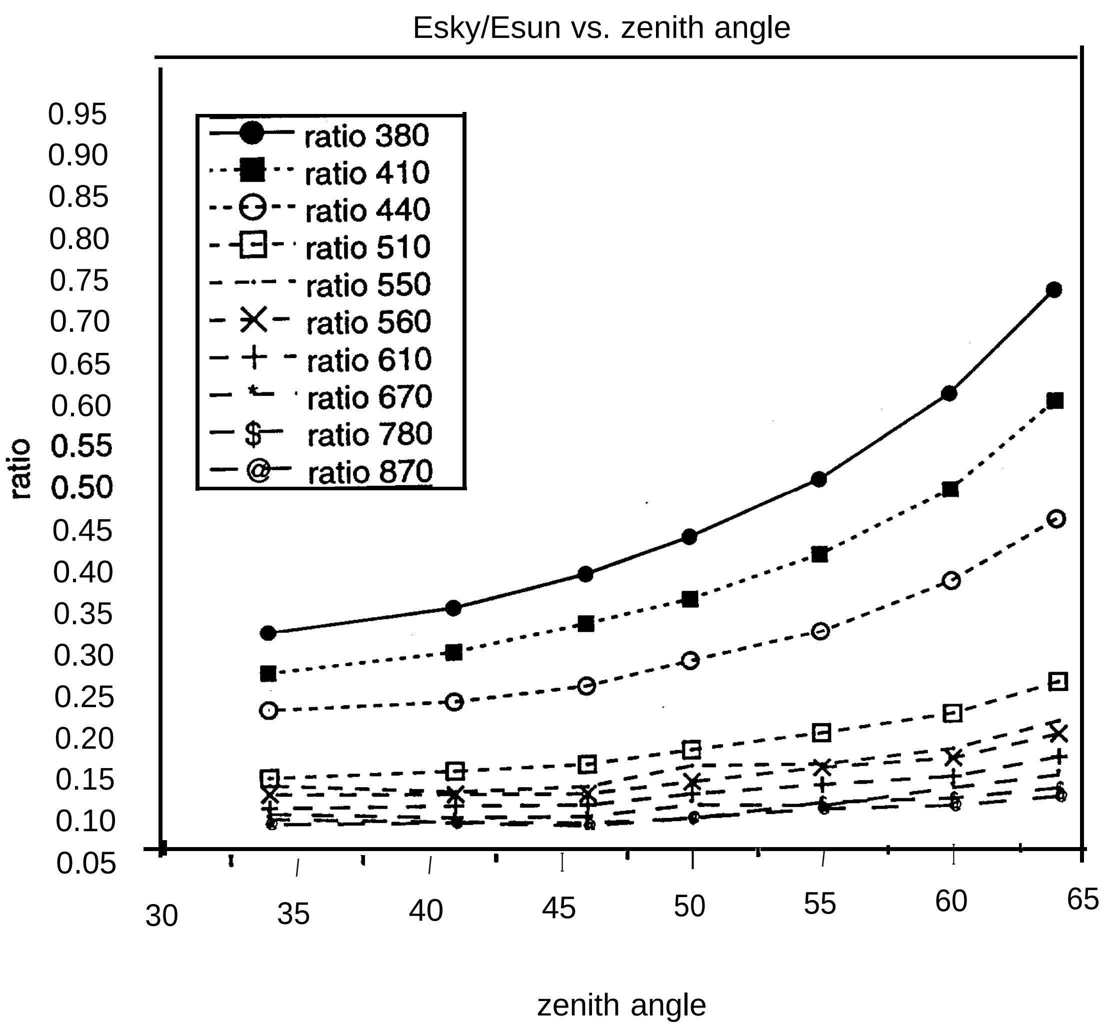

Esky/Esun vs. zenith angle
ratio 380
ratio 410
ratio 440
ratio 510
ratio 550
ratio 560
ratio 610
ratio 670
ratio 780
ratio 870
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
ratio
30
35
40
45
50
55
60
65
zenith angle

FIGURE 12.

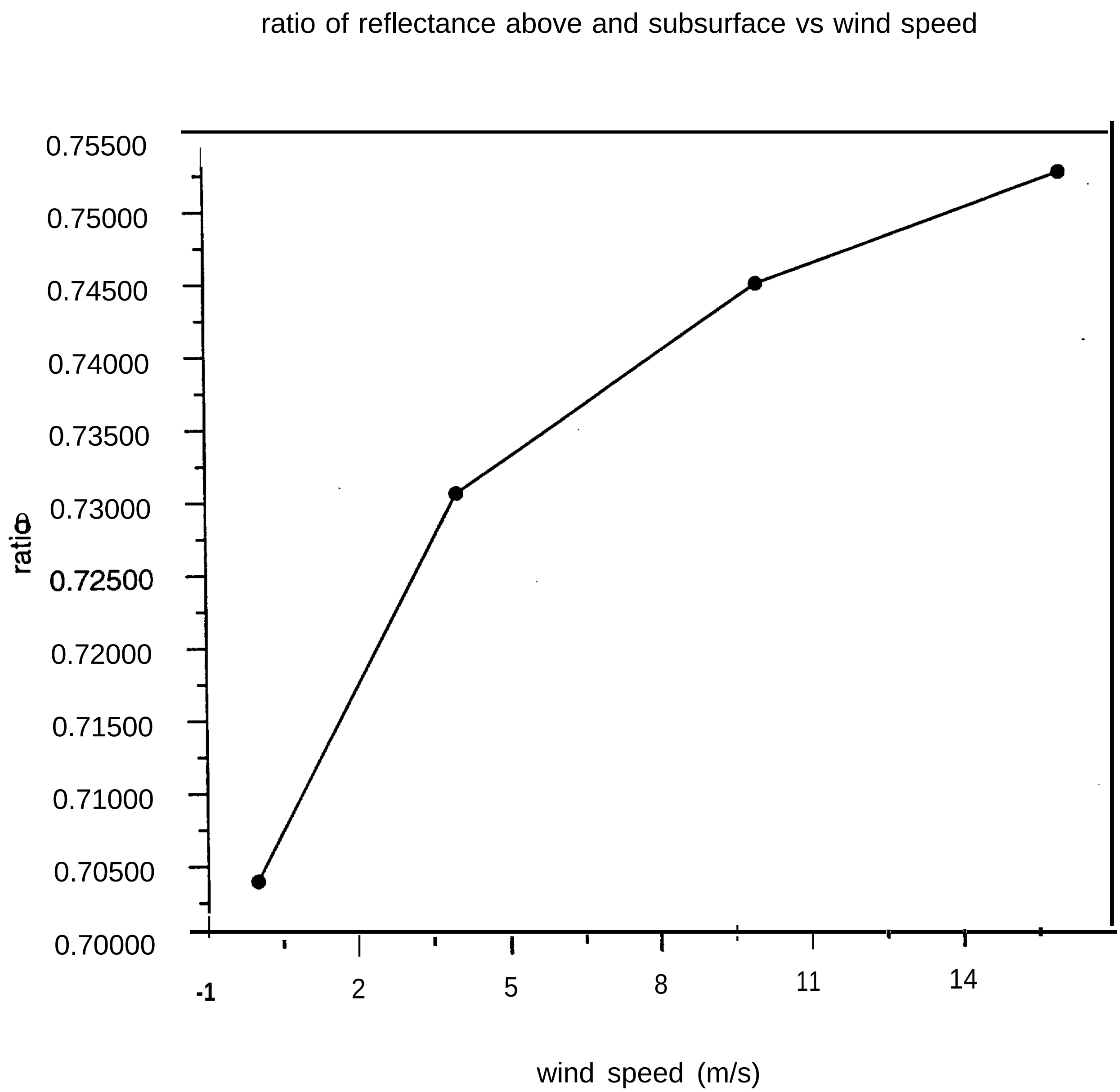

ratio of reflectance above and subsurface vs wind speed
0.75500
0.75000
0.74500
0.74000
0.73500
0.73000
0.72500
0.72000
0.71500
0.71000
0.70500
0.70000
ratio
-1
2
5
8
11
14
wind speed (m/s)

FIGURE 13.

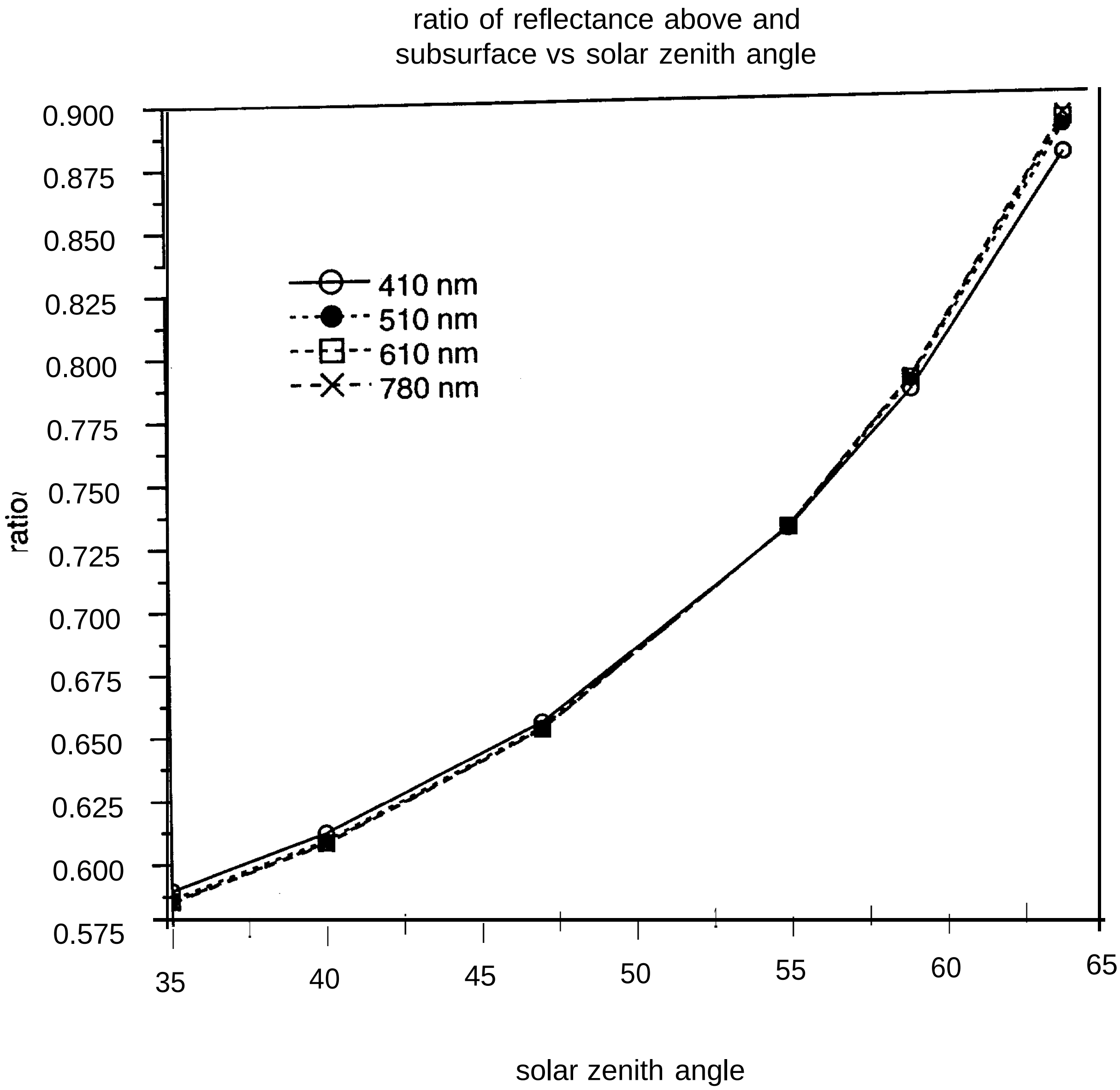
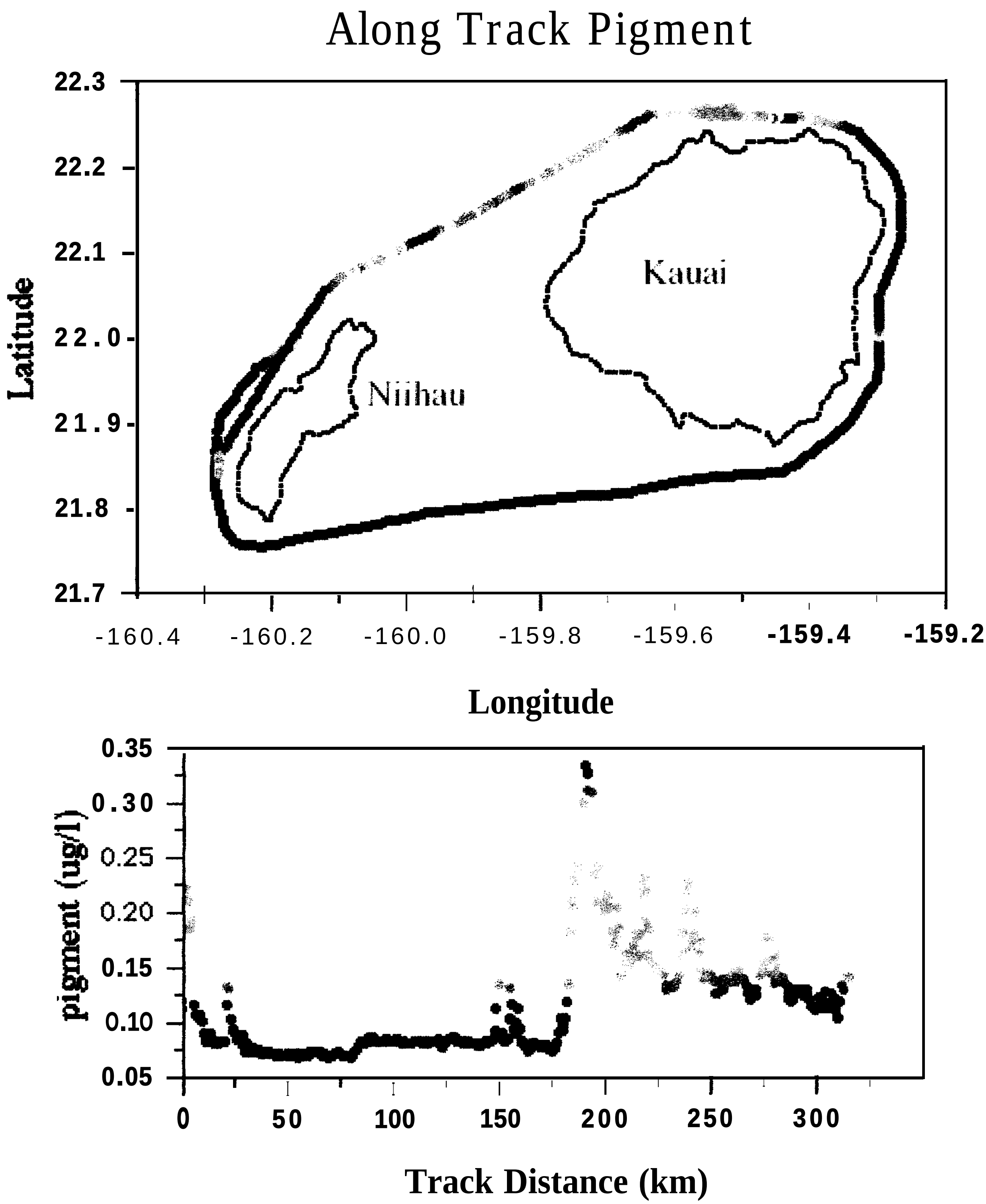
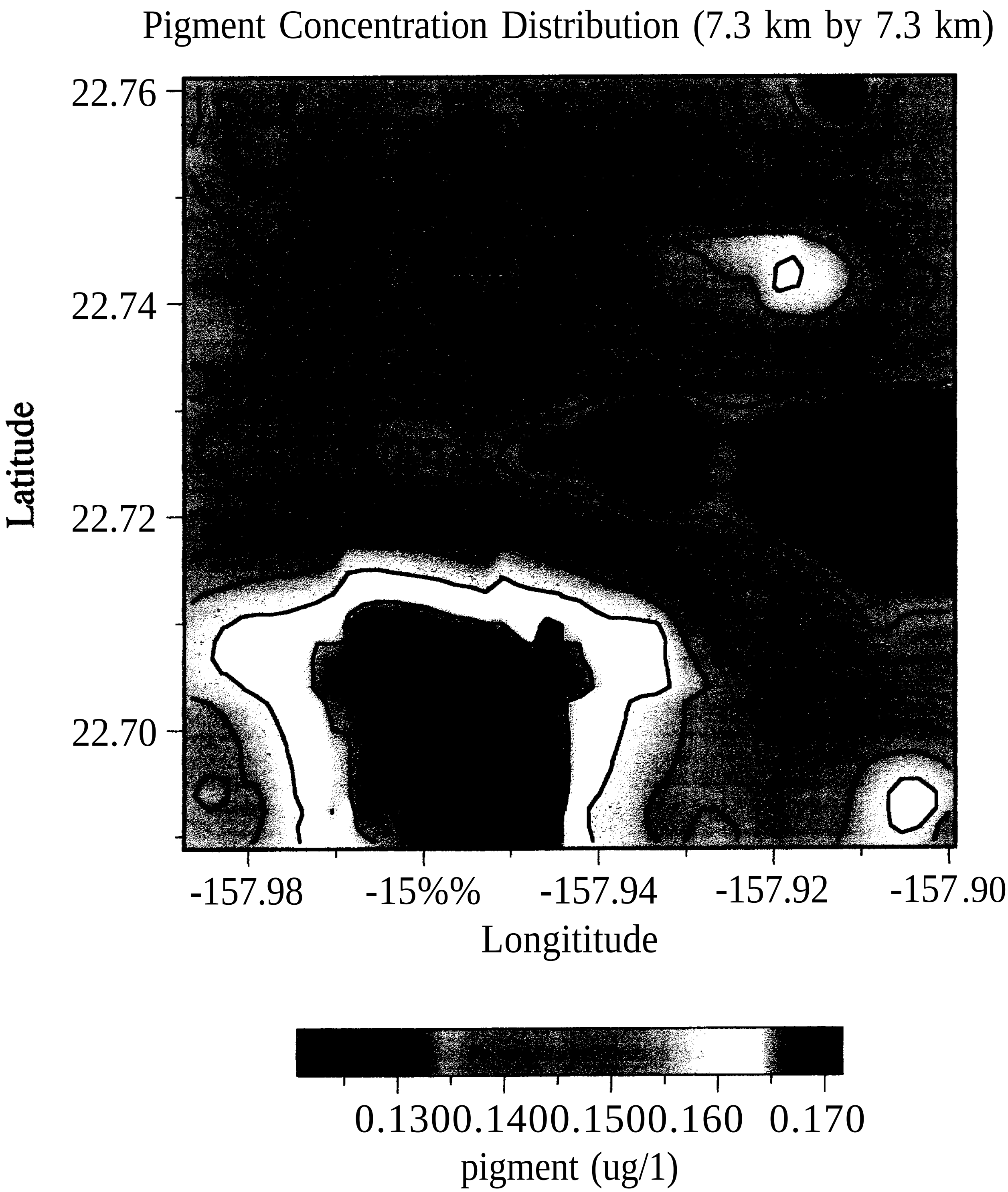

ratio of reflectance above and
subsurface vs solar zenith angle
0.900
0.875
0.850
0.825
0.800
0.775
0.750
0.725
0.700
0.675
0.650
0.625
0.600
0.575
ratio
410 nm
510 nm
610 nm
780 nm
35
40
45
50
55
60
65
solar zenith angle

FIGURE 14.



Along Track Pigment
Latitude
Longitude
Kauai
Niihau
22.3
22.2
22.1
22.0
21.9
21.8
21.7
-160.4
-160.2
-160.0
-159.8
-159.6
-159.4
-159.2
pigment (ug/l)
Track Distance (km)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
50
100
150
200
250
300

FIGURE 15.



Pigment Concentration Distribution (7.3 km by 7.3 km)
22.76
22.74
22.72
22.70
Latitude
-157.98
-15%%
-157.94
-157.92
-157.90
Longititude
0.1300.1400.1500.160 0.170
pigment (ug/1)

FIGURE 16.